

## Accelerator Systems Division Highlights Ending August 26 and September 2, 2005

### Installation

Craft Snapshot 8/2/05

ASD productive craft workers	45.0
Foremen (Pd by 15% OH)	5.0
HSM management (Pd directly)	3.0
TOTAL AMSI WORKERS	53.0
Less WBS 1.9, 1.2 etc	7.0
Less absent	4.0
TOTAL PD BY ASD/ORNL DB WPs	34.0

### Accelerator Physics

- The AP group is continuing to staff 24x7 shifts for SCL commissioning. This week we achieved  $2 \times 10^{13}$  ions/pulse at 865 MeV transported to the linac dump in a 180 microsecond, 20 mA beam pulse at 0.5 to 1 Hz. Losses continue to be concentrated near the SCL/HEBT interface, and are probably due to a small component of off-energy particles. Commissioning studies are continuing, with emphasis on understanding the transverse dynamics and the measured beam losses.
- Investigation of an alternative method of measuring the relative beam/RF phase using the beam-induced signal in the SC cavities shows that the error is dominated by noise in the phase measurement without beam. Further studies at higher peak currents are continuing
- A prototype nanocrystalline diamond primary stripper foil for the Ring was installed in the LANSCE Proton Storage Ring on 23/Aug. Beam tests are planned for the next beam development time on 18/Sep.

### Operations:

- Ran beam for commissioning studies and reached  $2 \times 10^{13}$  Protons Per Pulse, part of the SCL Performance Milestone
- Made significant progress on Beam Loading Compensation and Loss Minimization
- Down time contributors this week included:
  - HVCMs CCL3, DTL5, SCL21
  - Cold Cathode Gauges
  - MPS
  - DTL-6 RF
  - Water Cooling Systems, Tower/DI/RCCS
- Completed some of the Beam Fault studies, evaluating data
- Created a running plan for post CD-4 and FY 07 which is being evaluated by ASD-XFD Operations
- Worked to develop a power monitoring measurement program which we ran this week.

### Ion Source

- We assisted operations in reducing the beam current.
- We continue to accumulate quotes for high priority spares to be acquired at the beginning of FY06

### Survey and Alignment

RING:

- The Ring Injection Dump (RID) remote handling rails aligned and set for elevation (again), and the RID remote handling unit was fiducialized. Also, the Extraction kickers were internally mapped, and the results compared with the latest Brookhaven data.

RTBT:

- The monthly settlement monitoring campaign revealed that another 0.91 mm of settlement had occurred at the interface during the past month (7/22/05 – 8/19/05). This is not significantly different from the previous month's settlement: 0.95 mm. The lowest point is now 7.366 inches below design elevation.
- The rad-hard quad mock-up stand rails were leveled.
- The Rad-hard mock-up stand rails were leveled. The Extraction Dump flight tube was aligned in X and Y.
- The Extraction Dump flange was aligned in X and Y, then welded, and then a final as-built survey was performed.
- Survey & Alignment leveled 18 Rad-Hard rail mounting plates.
- Differential leveling was performed between the RTBT tunnel and the top of the Target Core Vessel, in order to check the vertical consistency between the accelerator tunnel and the Target building.

TARGET:

- A laser tracker was moved onto the beamline #2 poured-in-place, and alignment of the chopper stands was started.

- A check was performed on the centering of the target module water sheath, relative to the target cart rails. An offset was found (0.093 in).
- Nine fiducial holes were drilled to enable settlement monitoring of the core vessel and associated shielding.
- Beamline #17 shutter alignment was verified, and the newly designed and fabricated shutter alignment tray fixture was tested.
- A Target settlement monitoring campaign was started, to encompass the entire Target Building floor, Hot Cell, and top of core vessel. Elevation ties were made into the RTBT tunnel to ensure continued vertical consistency between the RTBT and Target.
- Differential leveling was performed between the Hot Cell and the top of the Core Vessel and the RTBT tunnel. Settlement monitoring points were established on top of the Core Vessel, and an initial set of baseline observations were carried out.
- Beamline #4 cave roof elevations were set out.
- Erased beamline #13 lines for concrete forms (second time this has happened due to bad information given S&A).

#### MAG. MEAS.:

- The last 30Q58 was fiducialized in the magnet measurement area. This is the last magnet to be fiducialized there.
- "Rough" alignment was performed on the extraction dump dipole antenna. Due to the design of this antenna, no "precise" alignment is reasonably possible.
- S&A began alignment of the extraction dump antenna stands. S&A also began re-alignment of 30Q stand to accommodate the extraction dump dipole antenna.

### Mechanical

#### Water Systems Installation

- Installation of the RTBT Collimator cooling system pneumatic lines continued.
- Installation of the RTBT vacuum sector valve pneumatic control lines continued.
- Fabrication of the RTBT/Target Quad cooling manifold continued.
- Preventative Maintenance on the Linac water systems continued.
- A series of Ring magnet temperature measurements were taken to quantify the source of an overheating issue
- The following items are submitted for your information regarding the Water Systems Installation activities ending the week of Sep 02
- The characterization of the water circuits' flow in the Ring half-cells was started.
- The water flow in the HEBT 12Q45 magnets was performed prior to their power testing.
- A flexible coupling failure in the Ring magnet pumping skid was repaired and the system placed back into operation.
- A leak in one of the RF cabinets in the Ring Service Building was repaired
- Fabrication of the RTBT/Target Quad cooling manifold continued.
- Preventative Maintenance on the Linac water systems continued

#### Ring Systems Installation

- The HEBT Charge Exchange Scraper modifications were tested and the balance of the units (7) released for modification.
- The Ring / RTBT vacuum Ion Pump procurement was released.
- The Ring / RTBT vacuum Ion Pump controller procurement was released.
- The Ring / RTBT vacuum Gauge controller procurement was released.
- The RTBT beamline drift pipe # DP11 and Sector Gate Valve SGV12 were installed.
- The RTBT beamline from magnet QV05 through QH12 was leak checked and pumped down.
- The RTBT 21Q40 magnets QV13, QH14 and QV15 were installed.
- The RTBT/Target quad magnets' assembly/test stand rails were aligned
- The RTBT/Target quad magnets' tunnel rail installation was started
- The RTBT EDUMP 30Q44 magnet assemblies EDUMP Q01 and Q02 were prepared for installation
- The Ring Collimator straight section beamline was completed from Collimator #3 thru the QMM/Tune Kicker assy.
- The Ring Extraction straight section kicker chambers were opened for a survey of the individual kickers.
- The RTBT beamline diagnostics Wire Scanner WS02 and BCM02 were installed.
- The RTBT beamline from magnet QH16 through QV19 assembly was installed, leak checked and pumped down.
- The RTBT magnet QV13, QH14 and QV15 assembly stands were shimmed for alignment.
- The RTBT EDUMP flight tube beamline adaptor was installed.
- The RTBT/Target quad magnets' tunnel rail installation continued.
- The RTBT/Target quad magnets' tunnel utility installation was started

## Electrical

- Ring Power Supply Testing. We concluded our 2 week test of the main ring dipole power supply and quadrupole power supplies. We were able to operate all 7 supplies at the 1 GeV point and successfully calibrated and integrated 6 of 7 supplies with the EPICS control system. Due to water supply problems we were not able to calibrate and integrate RING\_Mag:PS\_QV03a05a07, nor operate any of the supplies above the 1 GeV point. Subsequent temperature measurements of the magnets made jointly with the Mechanical Engineering group suggests that better balancing of water flows are needed. Also, due to electrical interference problems, we were not able to run all 6 quadrupole power supplies simultaneously. The power supply manufacturer is designing EMI filters to address this. We will correct these problems and retest shortly. Next week testing of power supplies powering magnets from the HEBT ground break to the Ring will commence.
- Electrical Installation. All Ring Service Building BPM and BCM cables have been terminated. A fiber optic reference cable has been pulled from the HEBT Service Building to the Ring Service Building. Installation continues on Ring Service Building AC power and Extraction Power Supply cabling. Electrical service for a new laser in the HEBT Service Building has been installed. Work has started on revised LEPT chopper cabling and rack installation in the Front End Building.
- SCL-Mod21 failed due to an open connection on the B phase rectifier assembly which required 1 ½ days to repair. The new IGBT driver card, which incorporates anti-saturation circuitry, faster rise and fall times on the gate signals, improved noise immunity, and connectorization of all I/O, was completed and testing was initiated (see attached picture). LEPT chopper system EMI racks were installed and conduit runs completed. All CCL modulators were re-calibrated and all warm linac modulators were upgraded with new voltage ramp algorithm software.



## HPRF

### Ring RF

- We have completed the interlocks required to operate Station RF21 Cavity Tuning Supply and most of the remaining Station RF21 equipment.
- We operated the Cavity Tuning Supply for Station 21 at low current, 50 Amperes out of a nominal 300 Ampere operating level. The limiting factor was a lack of Ring Tunnel access to verify the cavity connections.
- We have brought the entire Station RF21 system up to a Standby level in which the Final Amplifier cooling blowers and all the equipment rack blowers are operating, ready for Final Amplifier filament power.
- We are about 30% through the planned checkout procedure for Station RF21.

## LLRF

- The primary group task is ongoing support of the linac beam commissioning run.
- Checkout of the Ring LLRF control system installation is in progress.
- Two RF technicians have been assigned to Ring BPM installation for approximately 2-3 weeks beginning Friday, Aug. 27.
- The LLRF IOC software was upgraded on Monday to improve the beam loading compensation. The new algorithm should be less susceptible to noise (the previous version accumulated noise over time and needed occasional resets).
- A firmware and software upgrade is being tested in the lab and will be ready for deployment near the end of the week. Its primary purpose is to inhibit beam in case of regulation errors, but to not truncate the RF pulse when said errors are detected. Truncation of the RF pulse makes recovery from these faults nearly impossible without turning off the RF drive, which incurs longer beam interruptions.

## Cryo Systems

## Controls

- Along with a distressing array of operational problem this week, the Machine Protection System held the SCL off for extended periods twice. The symptoms were misleading, but in the end the faults were trivial – one broken cable termination and one inadequately seated board. A thorough inspection of installed components will be scheduled.
- Although it is commonplace in ASD to catch a tiger by the tail, the Personnel Protection Team, with a lot of help from their friends, this week successfully took a LION by the tail and shoved it through a hole into the Linac tunnel, where, after attaching cables, instruments and software, it is now gathering data.
- Some improvements have been made to the LLRF Adaptive Feed-Forward (AFF) system. These await beam for testing. The LLRF field control module (FCM) trip indicator now causes AFF to pause. Another LLRF improvement will stop the beam but not the RF system on regulation error excursions.
- When the RCCS and QMCS water pressures dropped low enough to open their makeup valves the auto-fill sequence timed out in ten seconds – before the pressure was reached which would cause the valve to close. This was requiring operators to manually reset the auto-fill sequence. All RCCS and QMCS PLCs auto-fill sequences were increased from ten to twenty seconds to allow for longer fill times.
- The DTL, CCL, SCL and HEBT vacuum IOCs are now all running with the new release of the serial driver. Some displays have been updated. Work is continuing on conversion of the Front End vacuum system to the standard.
- The Controls Team supported a test of the Cooling Tower as part of understanding PUP requirements. The test was very successful on the condenser side. The tower side had about half the desired temperature drop we wanted but was probably as good a test as was possible under the constraints imposed (less than 15 MW total power draw). The data is now being analyzed.
- Work continued on the LEBT chopper, including installation of the enclosures, modification of the existing controller prototype and design of the “next generation” chopper.
- A tool which facilitates the quick addition of an ad hoc archive is now available for testing. This can be used when an experiment is being done and one wants to archive, plot and correlate some limited number of process variables for a brief period.
- The RING/RTBT vacuum installation schedule was completed and it is now folded into the master schedule. The RING vacuum control installation of PLC components will start next week. The 2nd RTBT Vacuum controls rack is ready, completing all the ring vacuum controls equipment. The associated plant should be installed in the RTBT Service Building next week.
- Integrated power supply tests and calibration for -30% ~ +10% of 1 GeV range have been completed for the Ring Dipole power supply as well as QH10a13, QH02a08, QH04a06, QV01a09 and QV11a12. A controls integration test was completed for the ring injection kickers with a 5000 point waveform. An operator interface for Ring magnet controls was defined in consultation with the physics and power supply groups. Ring power supply testing will continue next week and into next month.
- A new DMZ server that uses one time passwords is now fully functional. When all those who need them have obtained smart cards, this will become the only access method.
- There are currently two branches in the LLRF software to support two firmware versions. One of these, having dual feed-forward buffers, allows the adaptive feed-forward (AFF) algorithm to turn on or off depending upon whether or not there is beam.
- A logical problem in the timing system related to handling of MPS “auto-reset” faults was discovered and fixed. The fault had the effect of causing the AFF to continue to learn under some no beam situations. After fixing this problem operations reported that beam was more stable and that losses were so low “we had to check the BLMs to make sure that they were still working.”
- The FE Vacuum system had a design problem for the ion pump control chassis. These chassis control 8 ion pumps using the Varian controllers. The analog signals monitoring the pressure and voltage readbacks in these chassis had been improperly grounded. This design problem seems to work with older Varian controllers but not with newer ones. Sixteen FE were modified.
- A new scanner driver for Allen-Bradley is ready for test in a PLC5/FlexIO test bench to be set up next week.
- The Controls Team supported 2.1K operations, in particular the heater sequence (aka cryogenic system energy management.) It has been decided to use a simple “RF on” bit for each cavity as the RF Load parameter (cavity RF on => RF Load of 1 Watt). A new heater sequence version will be loaded during the next SCL RF down time.
- Installation of the RING vacuum control system has started. The first vacuum PLC control panels are installed for RING PLC1. The two vacuum racks for the RTBT were not installed this week; the Electrical group wanted to delay a few weeks before installing.
- An archive data server problem with very small or very large numbers was discovered and fixed (or worked around).
- EPICS databases, sequences and screens were developed to support the “No-IOC-Left-Behind” test scores in an attempt to encourage IOC engineers to keep their IOCs up-to-date with respect to versions and operating status, as well as other

details yet to be developed. One of the more competitive IOC engineers had dealt with a few issues within an hour and moved to the top of the rankings.

- Analysis of the cooling water test data gathered last week was completed.

### **Beam Diagnostics**

#### Wire Scanners:

- Prototype HEBT to RTBT wire scanner is assembled and ready for installation. We hope to install this wire scanner between Quads 9 and 10 of HEBT. The Linac dump wire scanner is installed, electronics are checked out but the MPS limit switches need adjustments. We need an access to complete that job. We plan to install 12 wire scanners for the Ring and RTBT commissioning based on the ORNL prototype.

#### BLMs:

- BLM test stand is moved to the CLO. It will be ready for software testing in one week. EE group was informed by the US custom that HV cables have arrived. Fast BLM software is ready for testing in the LINAC next week.

#### BCM:

- purchase of RTBT BCM card to start development
- investigate SCL BCM00 (signal was lost again) and rewired cable to second channel of digitizer board
- setup BCM demo for community day

#### Software development

- Harp: purchase of board additional digital IO, CompactRIO controller back from NI with updated firmware
- Laserwire: new tool to display and analyze laser wire data.